NI SOFTWARE PACKAGE MULTISIM FOR ANALYZING OVERVOLTAGES IN A 6 kV ELECTRIC NETWORK

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Abstract: This work considers the analysis of overvoltages (surges) occurring in 6 kV power networks and their impact on electrical equipment. The research process used one of the modern software tools, the NI Multisim package. With the help of this program, a model of the power network is created and overvoltages occurring in various operating modes (load changes, short circuits, switching processes) are modeled.During the work, the causes of overvoltages, their amplitude and duration are determined, and their negative impact on network elements is analyzed. Also, based on the simulation results, effective technical measures are proposed to reduce and prevent overvoltages.

Keywords: 6 kV power grid, Overvoltage, Switching processes, Short circuit, Power grid model, NI Multisim, Simulation, Electrical equipment protection, Energy efficiency, Voltage analysis.

Introduction

Currently, in the Republic of Uzbekistan , electrical networks with a voltage of 6-35 kV are operated with various neutral modes: isolated neutral, compensated neutral (neutral grounded through an arc-suppressing reactor), resistive-grounded neutral [1].

The main advantage of these networks is their high reliability in power supply to consumers during single-phase ground faults. However, the weak electrical connection of these networks to zero ground potential inevitably leads to significant overvoltage in the network [2].

The high accident rate of 6–35 kV electrical networks makes it important to improve the reliability of electricity supply to consumers.

In this work, a computer simulation of overvoltages in a 6 kV network during a single-phase ground fault was performed in the NI software package. Multisim . Based on the simulation results, oscillograms of transient processes during the development of overvoltages were obtained, and the overvoltage multiples were calculated for various operating modes of the network neutral,

To simulate overvoltage, one section of the PS-6 kV substation busbars with outgoing cable lines was selected (Fig. 1).

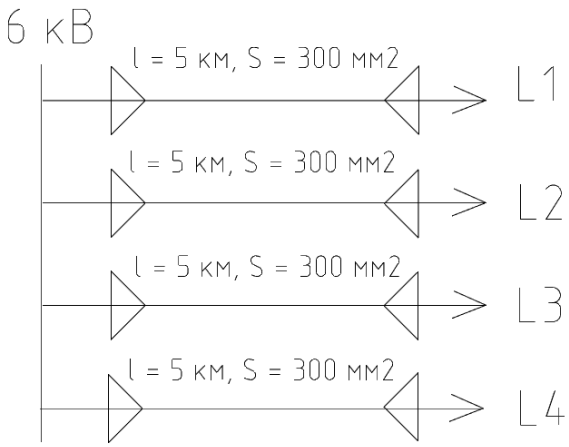


Fig. 1 . Busbar section of the RU-6 kV substation

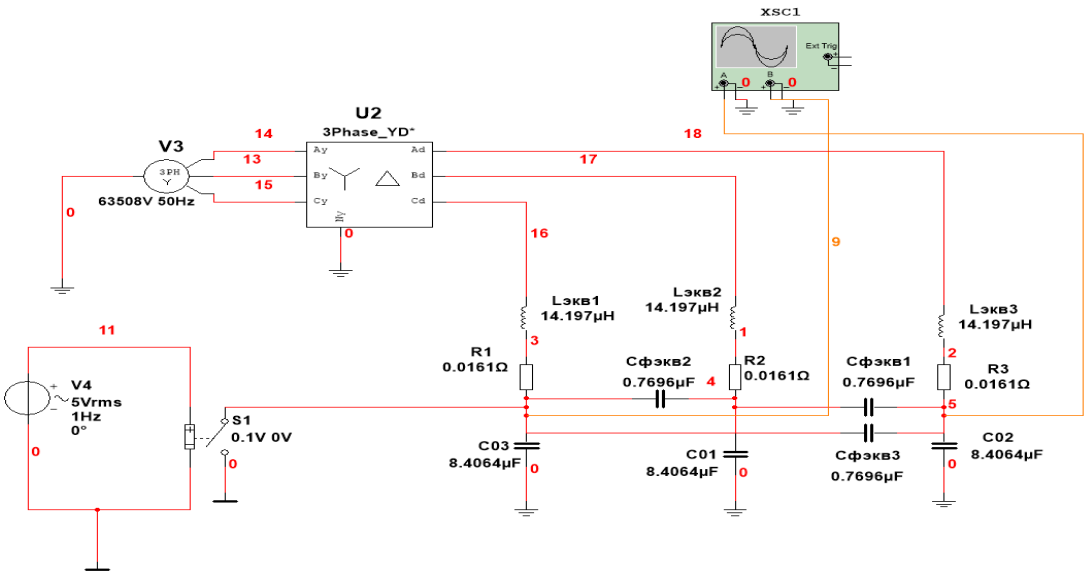
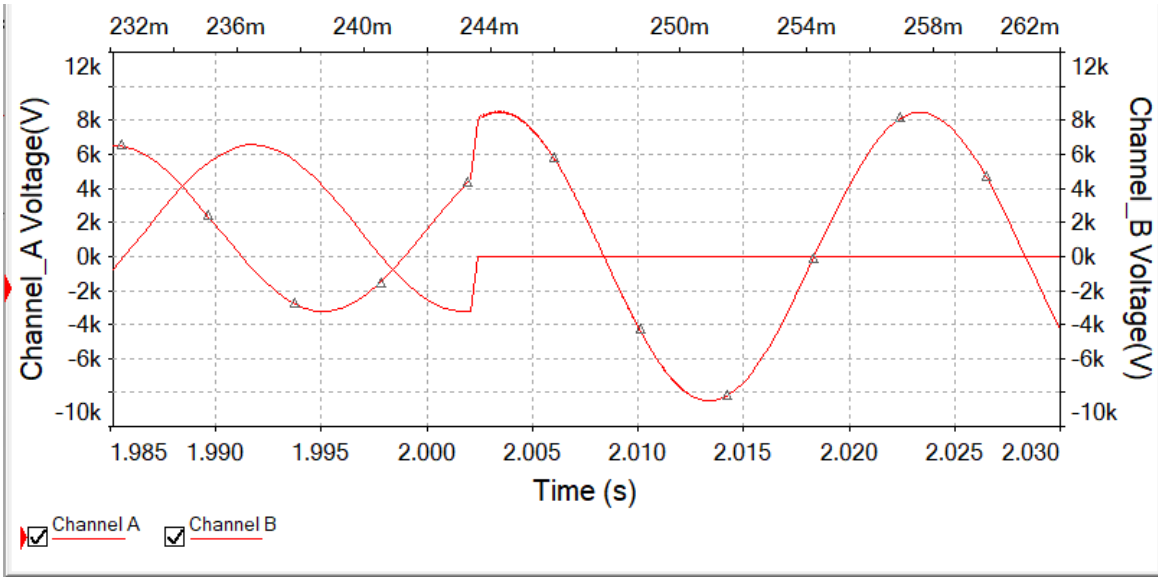


Fig. 2. Scheme For overvoltage modeling when phase C is short-circuited to ground

Having calculated the necessary parameters of the equivalent circuit and entered it into the working area of the software package (Fig. 2), we will conduct an analysis of overvoltages on the simulated section of the substation busbars during a short circuit of phase C to ground [3].

As a result of modeling in the NI Multisim software package, an oscillogram of voltages in the closed phase and one of the working phases was obtained (Fig. 3).



Rice. 3. Oscillogram overvoltage to short-circuit phase C to ground

According to the graph of the transient process during a short circuit of phase C to ground in a network with an isolated neutral, the amplitude of the maximum overvoltage was recorded U_{max}as 8567 V, with the amplitude of the highest working voltage $U_{ном\ фазное}$= 3463 V.

Coefficient overvoltage equals:

$$K = \frac{U_{max}}{U_{ном\ фазное}} = \frac{8567}{3463} = 2.47$$

Duration overvoltage equal 0.115 sec.

We will similarly simulate single-phase ground faults in phase C for other neutral operating modes. The simulation results are presented in Table 1.

Table – Values of the frequency and duration of overvoltage in the network under different neutral grounding conditions.

Neutral mode	To $_p$, o.e.	T $_p$, s
Isolated neutral	2.47	0.109

Continuation of the table

Grounding network through a resistor calculated using the general method	2.47	0.109
Network grounded through a low-impedance resistor	2.43	0.085
Network grounded through a high-impedance resistor	2.35	0.0534

This paper simulates overvoltage on a 6 kV substation busbar section under

various neutral grounding conditions. Oscillograms of transient processes were obtained during a ground fault when phase C was shorted to ground. The overvoltage factors were calculated from these oscillograms. The highest overvoltage factor and the longest transient process were observed with an isolated neutral. Based on the simulation results, a neutral grounded through a low-impedance resistor is the preferred method for reducing overvoltage factors in this network.

Conclusion

This work studies the issues of analysis and assessment of overvoltages occurring in 6 kV power networks. During the research, various operating modes of the power network were modeled using the NI Multisim software package and the causes of overvoltages were identified.The results obtained showed that switching processes, short circuits and load changes cause significant overvoltages in the network. This can negatively affect the reliability of electrical equipment. It was proven that it is possible to assess these processes in advance and determine the level of risk through simulation.

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